

APPLICATIONS OF COMPUTERIZED DIGITAL DATA ACQUISITION SYSTEMS

Computer Analysis Aids Battery Testing

A solution to a measurement problem for: TRW INC.
SYSTEMS GROUP
Redondo Beach, Calif.



An HP computerized system performs all data acquisition in the fully-instrumented cell/battery testing facility at TRW.

The Battery Test Facility at TRW in Redondo Beach, California is one of the most completely equipped private facilities of its kind in the country. The battery lab is staffed by engineers and technicians representing many years of technical expertise in designing, analyzing, manufacturing, and testing a great variety of battery configurations. The laboratory instrumentation is designed with a great deal of flexibility and adaptability for supplying its own in-house needs and for providing the full service of a central testing facility for other users requiring comprehensive cell/battery testing. Cells and batteries of all types are tested, the two most common being nickel-cadmium and silver-cadmium.

While the function of all batteries is essentially the same, namely, to provide an energy source, it is when rigid specifications are applied that a battery becomes a very significant and complex entity. Spacecraft applications, for example, probably represent the most demanding requirements for reliable battery performance; but these requirements can be accurately met only after extensive engineering and testing of every cell in every battery. At TRW, a battery intended for spacecraft applications is subjected to simulated space conditions and tested in strict accordance with the individual specifications of the battery based on the ultimate mission of the spacecraft. Similarly, the lab tests all batteries in accordance with individual specifications to assure long life and efficient operation.

DIFFICULTIES OF MANUAL TESTING

Applications for battery power-sources such as spacecraft, portable communications, and portable tape recorders are commonly known; however, the reliability and efficiency of the batteries themselves may not be as well defined as the device being powered. Traditionally, cells and batteries have been tested by manually reading meters and chart recorders and converting the readings to usable numerical form, *both of which are tedious and subject to interpretation errors.* At TRW, the need became apparent for an automated data acquisition system which would be faster and provide more reliable results than existing methods.

COMPUTER-CONTROLLED TESTING

TRW selected an HP 2116 computer system to handle the data acquisition needs of its battery test lab. *The computerized digital data acquisition system quickly proved to be much faster and more reliable than the previously-used analog meter reading methods.* Initially, the system was capable of measuring up to 300 inputs and providing outputs in both typewritten form and on magnetic tape. Successful operation of the system combined with increased operator proficiency convinced TRW that the remainder of its cell and battery testers should also be under control of the computer system. This led to an extensive upgrading of the original system to that shown in the block diagram. Now the system can measure up to 1200 analog inputs. These are divided among several separate and independent testing programs, which are typically in progress at any one time.

The entire system operates under control of a real-time executive (RTE) software operating system (as described below).

SYSTEM OPERATION

A variety of cell and battery test consoles is located throughout the laboratory, as shown in the photos. The actual units under test are set up in the rear of the consoles on special thermoelectrically temperature controlled base-plate heat sinks, thus offering a degree of protection from accidental damage while at the same time eliminating what would otherwise be a maze of front panel interconnecting cables. All wiring is run in overhead cable ducts to the system input patch panels. (This same arrangement is followed throughout the entire lab, which very closely resembles an industrial clean-room.) The patch panels, located in the uppermost position in the left and right computer system cabinets, allow channel number assignments to be made by merely plugging in small jumper wires on the panels. Thus, all available input channels can be used in the most efficient manner when setting up a new test.

Producing fully-tested batteries meeting specified performance characteristics involves at least the following four major steps: (1) Testing individual cells, (2) Selectively matching cells to be used in a specific battery, (3) Constructing a battery from the matched cells, and (4) Testing the battery.

Every cell received into the lab is subjected to very stringent incoming inspection tests. First, the cell is subjected to rigid physical inspection. Second, the cell is cycled repetitively (burn-in cycle) for the purpose of stabilizing its internal characteristics. This cycle usually averages about one week. Third, the cell is placed in a special charge and discharge cycle to establish reference data. Fourth, the cell is subjected to tests to determine the integrity of the cell terminal hermetic seals and internal plate separation system. Raw data from the tests in progress are available to the test engineer for monitoring purposes. He usually programs each test so that only selected portions of the data plus out-of-tolerance conditions, will be printed out. A quick scan through the printouts enables him to make decisions such as increase or decrease voltage, repeat a test, remove a bad cell, turn-on, turn-off, etc. At the same time, however, *all* the raw data is being recorded on 7-track (write-only) magnetic tape for subsequent reduction on a large computer at the in-house central computer facility. (Some data may also be stored on the disc memory, along with user program storage, and later written onto magnetic tape.)

Selection of cells to be used in a particular battery is based on computer analysis of results from the tests. The analysis lists the characteristics of each cell which are compared by the test engineer and matched as closely as possible. At TRW, considerable attention is given to the matching process because properly matched cells provide greater assurance that the battery will perform as specified. The number of cells that must be selected per battery varies in accordance with the actual voltage required. For example, a commonly used battery consists of 22 cells, nominally referred to as a 28-volt battery.

Battery testing follows much the same procedures as individual cell testing. A battery test involves testing both the overall battery and its cells, and includes temperature and pressure measurements. As part of a battery, the cell is no longer an individual entity, but one in a series of interconnected cells; when tested under these conditions, its performance may differ considerably.

For the temperature cycling tests, the battery is placed on a thermoelectric baseplate and then subjected to charge and discharge cycling at the temperatures called for in the battery specifications. (Again, the specifications are based on the application, and the tests assure proper operation under the environmental conditions expected in use.) In addition to the baseplate temperature indicator, a thermistor constantly monitors the battery to verify that the temperatures are in accordance with the specifications. Both the voltages and temperature cycling data are readily available in printed form for monitoring purposes. Other cell internal measurement parameters, available in printed form, include actual physical pressure, oxygen pressure, and potential difference between battery electrodes.

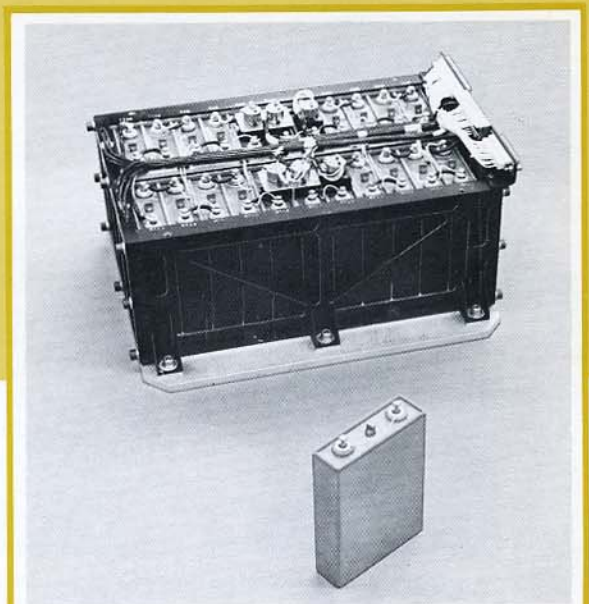
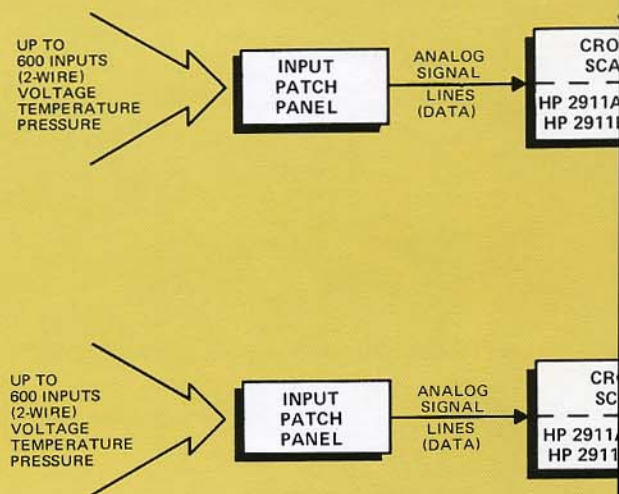
SOFTWARE FLEXIBILITY

The HP RTE software operating system allows TRW to operate several data acquisition programs simultaneously in real-time (foreground area of memory) concurrent with low-priority activities such as program compilation, debugging, etc. in the background area of core. Background activities can take place, without disturbing the system, while foreground data acquisition programs continue to execute. Under RTE control, data acquired from the various tests may easily be diverted to different units (for example, from one teleprinter to the other) to assure that no data are lost during maintenance or any other down time. In addition, the system allows normal data acquisition to continue even while outputting to low or medium speed devices. This is accomplished by temporarily storing (buffering) the data in memory and outputting the data at a rate to match the speed of the recorder.

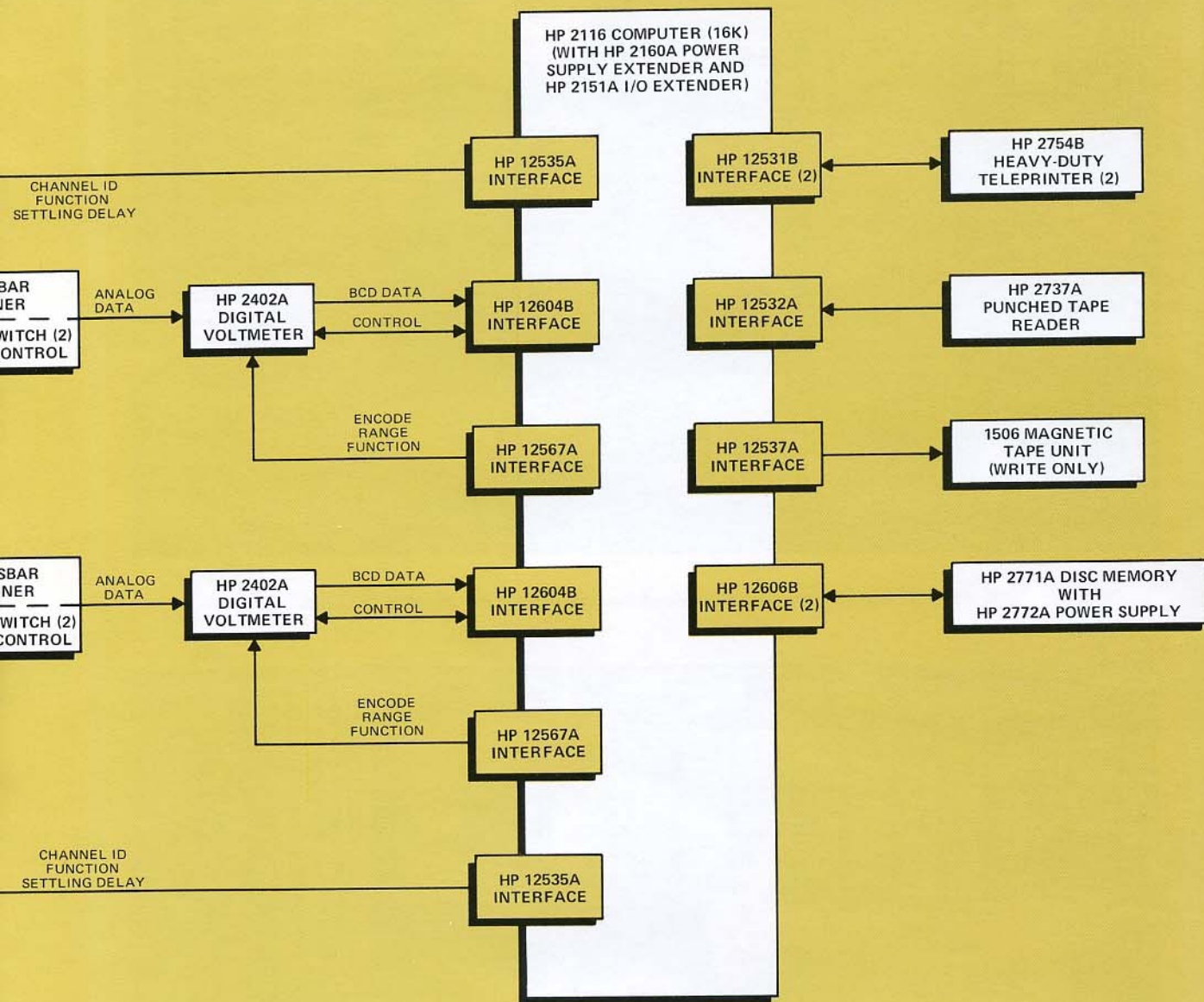
Minor data reduction is presently being done in real time with future plans for further data reduction in background. At the present time, plans are being developed to place as many of the manually-operated functions as possible under computer control in a closed-loop mode of operation, thus taking advantage of capability already existing in the RTE software operating system.

COMPUTERIZED DATA ACQUISITION PROVES FASTER AND MORE RELIABLE

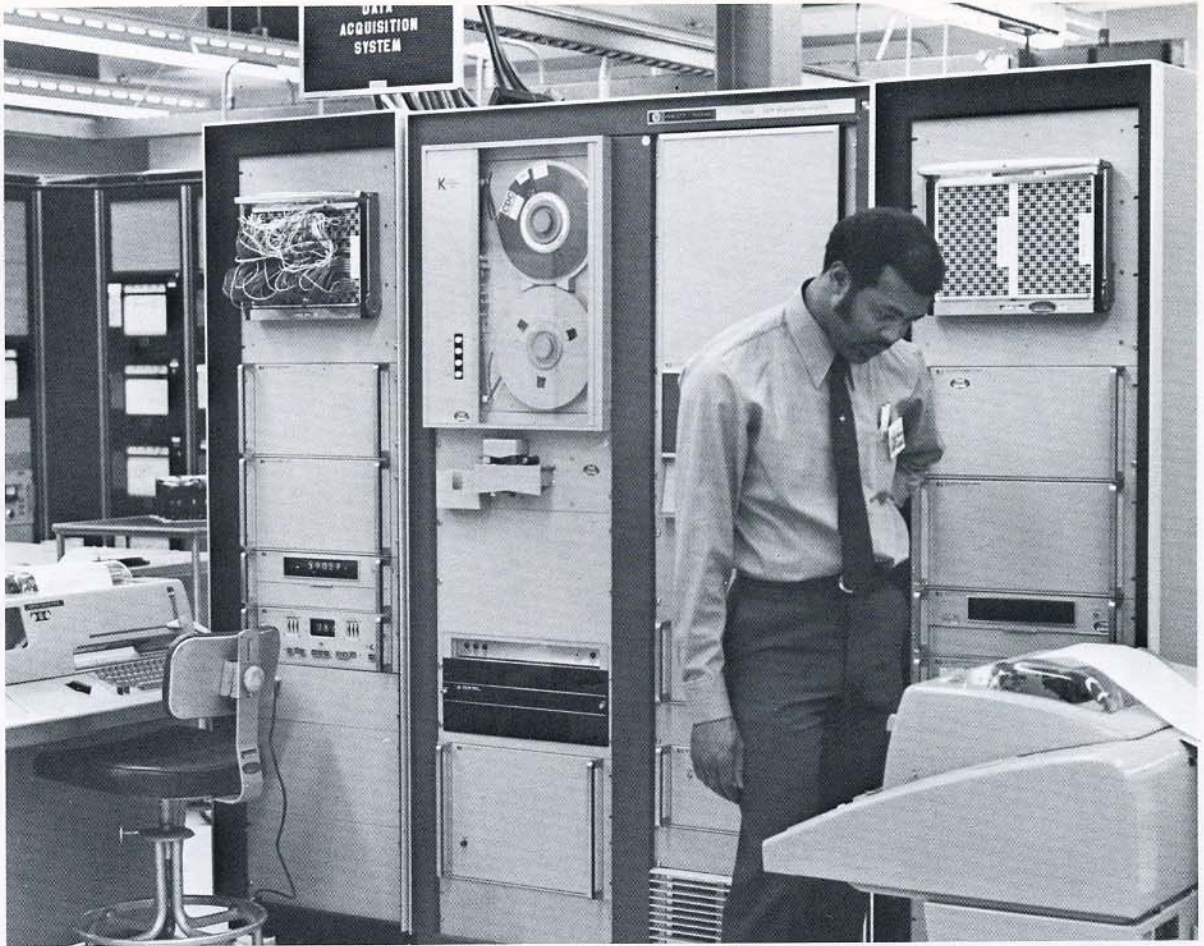
The HP computerized system has proved to be much faster than the previously-used analog recording techniques. In addition, the test results printed out in digital form are far more accurate and reliable because the usual interpretation errors from reading meters and strip charts are eliminated. Under closed-loop control the test engineer is freed from the tedious and time-consuming task of adjusting test parameters, and can spend his time on more productive battery development activities.



A cell and battery are ready for use — the result of comprehensive computerized testing.



1200-channel real-time computerized data acquisition system for cell/battery testing.



A test engineer quickly scans a printed log looking for any unusual readings.



Banks of modern instrumentation provide a wide range of cell/battery test parameters. Here, test engineers are evaluating a computer analysis while parameters are being adjusted for another battery test.



For more information, call your local HP Sales Office or East (201) 265-5000 ● Midwest (312) 677-0400 ● South (404) 436-6181
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